INNOVATIVE COKE OVEN GAS CLEANING SYSTEM
RETROFIT APPLICATIONS
QUARTERLY TECHNICAL PROGRESS REPORT NO. 1
FOR THE PERIOD COVERING
MAY 24, 1989 TO MARCH 30, 1990

PARTICIPANT

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BACKGROUND

Bethlehem Steel Corporation's (Bethlehem) Sparrows Point Plant operates three coke oven batteries which produce coke in support of steelmaking operations. Coke oven gas (COG), a by-product of the cokemaking operation, is treated in two parallel coal chemical plants to remove saleable constituent chemicals and to cleanse the COG of tar and oil for use as a plant fuel. A total of 72 million standard cubic feet per day (SCFD) of COG is being cleaned. After cleansing, about 40 percent of the COG is used as fuel for underfiring the coke oven batteries without directly desulfurization. The remaining 60 percent of the COG is desulfurized to satisfy existing regulations and the operating requirements of various plant consumers.

An Administrative Consent Order signed by the Maryland Department of the Environment and Bethlehem in October 1987 required that all COG be desulfurized. Inspections of the two coal chemical plants indicated that the existing desulfurization equipment and related facilities for cyanide removal and sulfur recovery have deteriorated to the point where a major rehabilitation/replacement program would be required to maintain acceptable environmental performance for the 60 percent of the COG which was already being desulfurized. The investment for this renovation program, coupled with additional facilities to desulfurize the balance of the COG, plus restoration of other segments in the two coal chemical plants (50 and 30 years old) caused Bethlehem to look for other alternatives that would be capable in meeting the environmental requirements and be more cost effective in the long term.

In lieu of rehabilitating existing facilities in-kind, modifications were proposed by Davy/Still-Otto (DSO) utilizing proven technology that innovatively combined would permit the existing two coal chemical plants to be operated as one plant. This proposal also qualified for the Department of Energy's (DOE) Clean Coal Technology (CCT) Program. If funding could be obtained to demonstrate this conversion, Bethlehem felt it was the project with the best return since the operating costs of material, labor, and utilities would be substantially reduced. Furthermore, funding from the DOE cost share under a cooperative agreement would shorten the capital return time, and demonstrate the technical and economic viability of the project.

In response to DOE's CCT-II solicitation, Bethlehem submitted a proposal to the DOE in May 1988. The proposal submitted by Bethlehem describes a unique integration of commercial technologies developed by Davy/Still-Otto to clean COG being produced at its Sparrows Point, Maryland steel plant. This innovative coke oven gas cleaning system combines secondary gas cooling with hydrogen sulfide and ammonia removal, hydrogen sulfide and ammonia recovery, ammonia destruction, and sulfur recovery to produce a cleaner fuel gas for plant use.

The primary environmental benefit associated with employing this innovative COG cleaning system is realized when the fuel gas is burned within the steel plant. Emissions of sulfur dioxide are reduced by more than 60 percent. The removal, recovery, and destruction of ammonia eliminates the disposal problems associated with an unmarketable ammonium sulfate by-product. Significant reductions in benzene and hydrogen cyanide emissions are also obtained.

Following an extensive review by the DOE, Bethlehem's innovative COG cleaning system demonstration project was one of 16 demonstration projects selected on September 28, 1988 to enter into negotiations. During negotiations Bethlehem requested approval from the DOE to initiate work on the demonstration project. Approval was granted by the DOE and work on the demonstration project began in the spring of 1989. The DOE approval was subject to the stipulation that demonstration project costs allowable for cost-sharing purposes would be recognized but not reimbursed by the DOE until a cooperative agreement was awarded to Bethlehem.

A cooperative agreement with a total estimated cost of $45,239,781 was awarded to Bethlehem on November 14, 1989. Under this cooperative agreement Bethlehem would provide 70.2 percent of the total funding requirements for the demonstration project with the DOE providing the remaining 29.8 percent. All the required National Environmental Policy Act (NEPA) approvals were granted on December 22, 1989 by the signing of the demonstration Project's Finding of No Significant Impact by DOE's Acting Assistant Secretary for Environment, Safety, and Health and the issuing of the final Environmental Assessment (DOE/EA-0404).

TECHNOLOGY DESCRIPTION

Traditional COG processing to remove sulfur and ammonia results in the production of both sulfur and crude ammonium sulfate. Ammonium sulfate is a by-product that is very difficult to sell and that requires sulfuric acid to produce. The technology to be demonstrated destroys the ammonia, thus eliminating problems with disposal of an unmarketable by-product and problems with handling sulfuric acid.

The proposed technology is a first-time integration of four commercially available technologies. The four steps, or stages, in the proposed process are the following: (See Figure 1)

- Secondary Gas Cooling

  This degree of cooling is commonly used in Europe, where standard operating practices produce lower gas temperatures at the inlet of the gas-processing equipment. The first coolers of the type used in this project were installed in the United States more than ten years ago in steelmaking facilities.

- Hydrogen Sulfide and Ammonia Removal

  This process was developed by Firma Carl Still specifically for the purpose of treating COG. Since the early 1950's, more than 40 of these plants have been built by Davy/Still-Otto and associated companies. The process was developed to allow removal of hydrogen sulfide from the COG using, as reagents, chemicals that are part of the process streams produced in normal coke plant operations. Early installations were tied to sulfuric acid production facilities but more recent installations have produced elemental sulfur. In either case, the process that removes the ammonia and hydrogen sulfide from the COG is the same.

- Hydrogen Sulfide and Ammonia Recovery

  This process, also developed by Firma Carl Still, consists of first removing the ammonia and hydrogen sulfide from the absorbing solution by contacting it with steam, and then recovering the ammonia and hydrogen sulfide gases by condensing the steam.

- Ammonia Destruction and Sulfur Recovery

  The basis for this part of the overall process is the Claus Plant, in which hydrogen sulfide and sulfur dioxide are catalytically reacted to produce elemental sulfur and water vapor. Many Claus Plants are in existence. Claus Plants produce sulfur from gas streams that are rich in hydrogen sulfide. The basic Claus Plant design was modified by Firma Carl Still to destroy the ammonia via catalytic decomposition in the first stage of the process. Subsequently, up to 96.5 percent of the sulfur present in the feed gas is recovered in the remaining stages of the Claus Plant. Modified Claus Plants of this type have been operating in Germany for over 20 years and in the United States since the late 1970's.

The process uses contaminated water produced in the coke oven plant to absorb sulfur compounds and ammonia. Both the sulfur compounds and ammonia are steam stripped from the contaminated water, and then the ammonia is destroyed in a catalytic reactor. This reactor is followed by a conventional Claus Plant that catalytically converts the sulfur compounds to elemental sulfur, which is sold. Since each process unit has individually achieved commercial status, the technical risk for the project is significantly reduced.

The benefits of this process are the reduction of sulfur, ammonia, and organic compound emissions in the plant, and no production of a solid waste.

PROJECT DESCRIPTION

Bethlehem's project will demonstrate the feasibility of integrating four separate process stages in the cleaning of coke oven gas. Each separate stage has been proven and several commercial-sized installations of each process stage are presently being operated. This project will be the first demonstration integrating all four of these technologies in a retrofit application.

This project will take place at Bethlehem's Sparrows Point Plant in Baltimore, Maryland, and will service a coke plant rated at a nominal production of 1.4 million tons per year of metallurgical coke.

This project is intended to reduce by more than 60 percent the current emission of sulfur dioxide at Sparrows Point, Maryland, from the combustion of COG. This reduction of sulfur dioxide emissions will be accomplished through the removal of hydrogen sulfide from the COG prior to its combustion. At present, only a portion of the COG is desulfurized with the current technology. The process to be demonstrated will remove 80 percent of the hydrogen sulfide from 72 million SCFD the COG produced. More than 98 percent of the ammonia will also be removed and destroyed. Changes proposed in the gas-processing system as part of this project will also result in reductions in the quantities of benzene and other volatile hydrocarbons emitted to the atmosphere. Specifically, the technical objectives of this project will demonstrate the following:

- o Simultaneous hydrogen sulfide and ammonia removal from COG, hydrogen sulfide and ammonia recovery, ammonia destruction and sulfur recovery resulting in a cleaner fuel gas for plant usage. Employment of this technology will substantially reduce
  - sulfur dioxide emissions when the fuel gas is burned
  - volatile organic emissions
  - ammonia discharge to wastewater treatment
- o Use of reagents indigenous in COG for hydrogen sulfide removal resulting in reduced costs for
  - purchase and/or handling of feed reagents
  - handling and/or treatment of by-products
  - utilities
  - manpower
- o Retrofit to an existing facility without significant downtime.
- o Operational reliability beyond the year 2000, and compliance with all environmental regulations.

The design for the demonstration project is based on operating data that have been collected from individual process steps or combinations of individual process steps that have been successfully operated to commercial size facilities. Because the demonstration facility will be designed to handle 72 million SCFD of COG per day, the demonstration project will be of a commercial size that is retrofitted into an above-average cokemaking facility. For this reason, essentially no scale-up is involved.

To achieve these objectives, the demonstration project is divided into the following three phases:

PHASE I	Design and Permitting
PHASE II	Construction and Start-up
PHASE IIA	Long-Lead Procurement
PHASE IIB	Procurement, Construction and Start-up
PHASE III	Operation

PROCESS DESCRIPTION

A simplified block flow diagram for the process is shown in Figure 1. The schematic process flow diagram for the retrofit COG-cleaning system at the Sparrows Point Plant is shown in Figure 2.

The COG entering the new cleaning system has been cooled by contact with flushing liquor in the existing piping that carries the gas from the coke ovens. Flushing liquor is obtained as a condensate from cooling the COG and contains water, tars and oils. It also contains a number of dissolved salts and gases. Tars and oils are separated and sold as by-products. Of the remaining material, which is mostly water with some tar and oil, a small portion is used as a makeup to the secondary cooler. Excess flushing liquor is treated in a wastewater treatment facility.

The COG that has been cooled in the existing primary coolers is passed through the existing exhausters (blowers) to increase gas pressure and then passed to the existing electrostatic precipitators to remove tar mist. The COG, which is then relatively free of tar mist, enters the new system.

The COG enters the demonstration project envelope at the secondary cooler. The gas passes upward through the secondary cooler and comes in contact with cool flushing liquor, which reduces the temperature of the gas. A small quantity of tar is added to the flushing liquor to dissolve any naphthalene that condenses from the gas. The warm flushing liquor is pumped through a coil of the wet surface air cooler (WSAC), where it is cooled and returned to the top of the secondary cooler. In the WSAC, the warm flushing liquor is cooled by blowing air and a water spray. The combination of air and wetting on the coil of the WSAC provides efficient evaporative cooling. In conventional systems, the flushing liquor is cooled in a cooling tower by direct contact with air. This results in the release of pollutants to the atmosphere. Some of the materials dissolved in the flushing liquor that may be released to the environment in conventional systems include benzene -- a carcinogen -- as well as ammonia, hydrogen sulfide, and hydrogen cyanide. Tar and fresh flushing liquor are continuously added to and removed from this circuit to prevent excessive salt buildup in the tar or flushing liquor.

The cooled COG leaving the secondary cooler section enters the hydrogen sulfide removal section, which also contains an expanded-metal packing to provide excellent contact between the gas and the flushing liquor. As in the secondary cooler, the gas flows upward and is contacted by a liquid flowing downward. The hydrogen sulfide is removed by absorption in the ammonia-rich flushing liquor stream. The ammonia-rich flushing liquor stream is recycled back from the hydrogen sulfide recovery section and the ammonia removal section.

The gas exiting to the top of the hydrogen sulfide removal section enters the base of the ammonia removal section. The liquid that flows downward is the clean flushing liquor that exits the bottom of the ammonia recovery section essentially free of ammonia and hydrogen sulfide. The ammonia is removed from the gas, and the clean gas returns to the existing facilities for further processing.

The flushing liquor leaving the base of the ammonia removal section, rich in ammonia, is pumped to the hydrogen sulfide removal section, where it absorbs the hydrogen sulfide as described previously. The flushing liquor, rich in hydrogen sulfide and ammonia, leaving the base of the hydrogen sulfide scrubber section flows to the top of the hydrogen sulfide recovery section.

In the hydrogen sulfide recovery section, the flushing liquor is countercurrently contacted with steam and ammonia vapors from the ammonia recovery section to strip the acid gases (hydrogen sulfide, carbon dioxide, hydrogen cyanide), along with some dissolved ammonia, from the flushing liquor. These gases are sent to the catalytic destruction section, where undesirable gases, such as ammonia and hydrogen cyanide, are destroyed. From the catalytic destruction section, the gas is passed to sulfur recovery section. The flushing liquor exiting the base of the hydrogen sulfide recovery section enters the ammonia stripper recovery section for ammonia removal by countercurrent contacted with steam. Sodium hydroxide is added in the middle of the column to release the ammonia that is chemically bound as fixed salts.

In summary, this process removes most of the sulfur, ammonia, and other pollutants in the COG, as reagents, materials contained in the COG. The bulk of ammonia and hydrogen cyanide present in the gas is destroyed. Using the new secondary cooler prevents the release of benzene, other volatile hydrocarbons, and traces of hydrogen cyanide, ammonia and hydrogen sulfide to the atmosphere.

SUMMARY

This quarterly technical progress report summarizes the activities in Phase I, Design and Permitting, Phase IIA, Long-Lead Procurement, and Phase IIB, Procurement, Construction and Start-up from project start on May 24, 1989 to March 31, 1990.

Technical Status

- Risk Analysis

  As part of the preliminary design effort, DSO prepared a risk analysis report for the demonstration project. The first ammonia removal section will be arranged to function as a standby secondary cooler/hydrogen sulfide absorber column. The use of a specially designed chimney tray will enable the scrubber to be split into two sections. Enriched liquor will flow via a seal pot to the enriched liquor buffer tank, thus keeping the secondary cooling liquor in the bottom section separate from the enriched liquor. In this way, tar in the secondary cooling liquor will not be allowed to contaminate the enriched liquor.

  The ammonia removal section will include two absorber columns. While using the first ammonia absorber column as a standby hydrogen sulfide absorber column, the hydrogen sulfide removal will not be as efficient; however, ammonia removal will be maintained at the design efficiency.

  The ammonia recovery section will include three ammonia stills, one for fixed ammonia and two free ammonia. The standby free-ammonia still will be capable of performing either the free- or the fixed-ammonia still duties.

  One of the major objectives of this demonstration project is to use an integrated system that can be retrofitted into coke oven gas handling systems to address a variety of environmental and operational factors in the most cost-effective manner. This is an attainable goal that is clearly seen in Figure 2's diagram. There is one change to the gas flow scheme. As shown in Figure 3 the 42" gas main has been revised to tie into the A & B Plant precipitators. This was done to give the by-product plant operators more options in the use of the precipitators; this is the most significant change from the original conceptual design.

Engineering Status

The civil engineering portion of design is complete, however minor adjustments may be necessary as a result of the structural design review. The structural design review has been completed and the overrun in weight substantially reduced, however the final cost will exceed the original estimate. The revised design will entail additional design work but the delay in ordering the structural steel will not result in a change in schedule but will require prioritized deliveries. Although there are some revisions necessary the piping arrangements have been included in the General Contractors bid package and also issued for fabrication bids.

The electrical engineering is 88 percent complete. All drawings for issue with the electrical bid package have been completed, however, the interconnecting drawings have yet to be completed.

Instrument engineering is 80 percent compete. Drawings were issued for bid packages.

Procurement Status

Following approval by Bethlehem's Board of Directors on April 26, 1989, we completed negotiations with DSO in May 1989 to provide technical services and equipment necessary for the modification/integration of Coal Chemical Plants A & B in accordance with DOE Cooperative Agreement No. DE-FC22-90PC89658. The contract with DSO included the following:

1. Project scope, estimate, schedule, process design, process flow diagrams, process and instrument diagrams, general arrangements, equipment design, equipment specifications, equipment procurement services, construction drawings and specifications, operating and maintenance manual information, equipment warranties and system performance guarantee.

2. Equipment

3. Services for quality assurance relative to equipment and equipment installation. Provide services for training, cold commissioning, live commissioning, fine tuning and guarantee testing of the system.

4. All technical and administrative assistance, data and information necessary to support Bethlehem's commitment to the DOE.

Fifty-seven purchase orders have been placed and seventy-nine inquiries have been issued. The structural steel inquiry package will be reissued after design changes are complete - additional vendors will be solicited.

Bids for large bore piping in titanium, stainless steel and carbon steel are being prepared for order by May 31, 1990.

Construction Status

The piling work is complete. The civil construction contract has been let, including the satellite buildings. Construction is scheduled to commence in May 1990 with foundation work. The General Contractor bid package is out on inquiry with bids due May 31, 1990.

Schedule

The results of our technical progress is limited to Phases I, IIA and IIB. See Figures 4, 5, 6 and Tables 1, 2, and 3. All of the work has been completed on Phase I. For all practical purposes the most important task of procuring long-lead items is complete in Phase IIA. Bethlehem is currently focusing all efforts on Phase IIB.

Financial Status

The Project's cost data covering Phase I & II and future spending projections is shown in Figures 7 and 8 and currently is "in control." As anticipated, the major spending will begin in the Third and Fourth Quarters 1990 when Phase IIB commences.

PLANS FOR NEXT QUARTER

Engineering design will be complete. Procurement of all major equipment and materials will be complete. A comprehensive construction schedule will require meetings/discussions with the civil and general contractor before the network is finalized.

The contract has been placed for the Environmental Monitoring Plan and several meetings will be scheduled to prepare this for submission by September 1990.

The Project Evaluation Plan will be completed by July 1990 and the Preliminary Public Design Report will be submitted by October 1990.

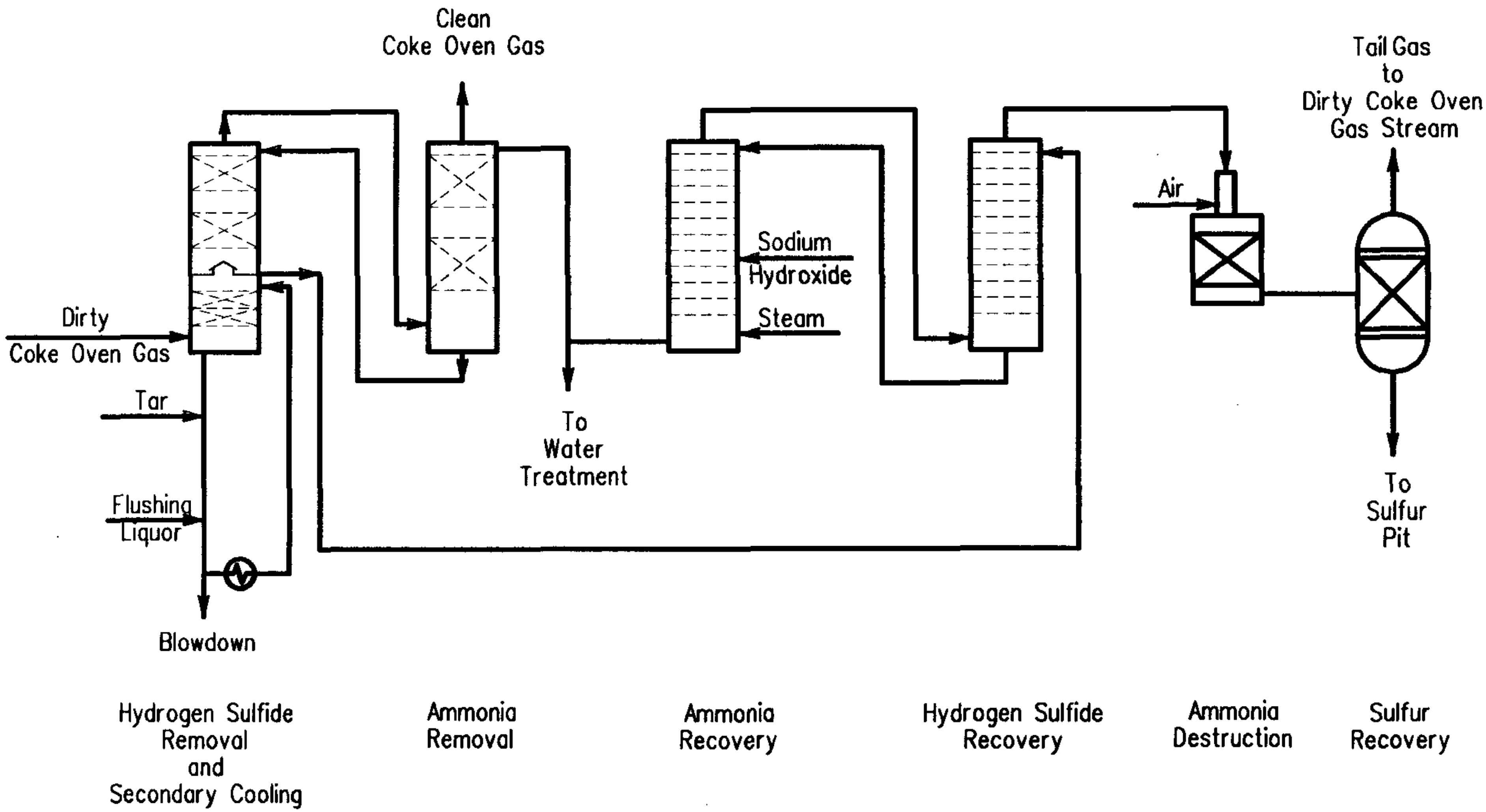

Figure 1 - Bethlehem Steel Corporation Innovative Coke Oven Gas Cleaning System

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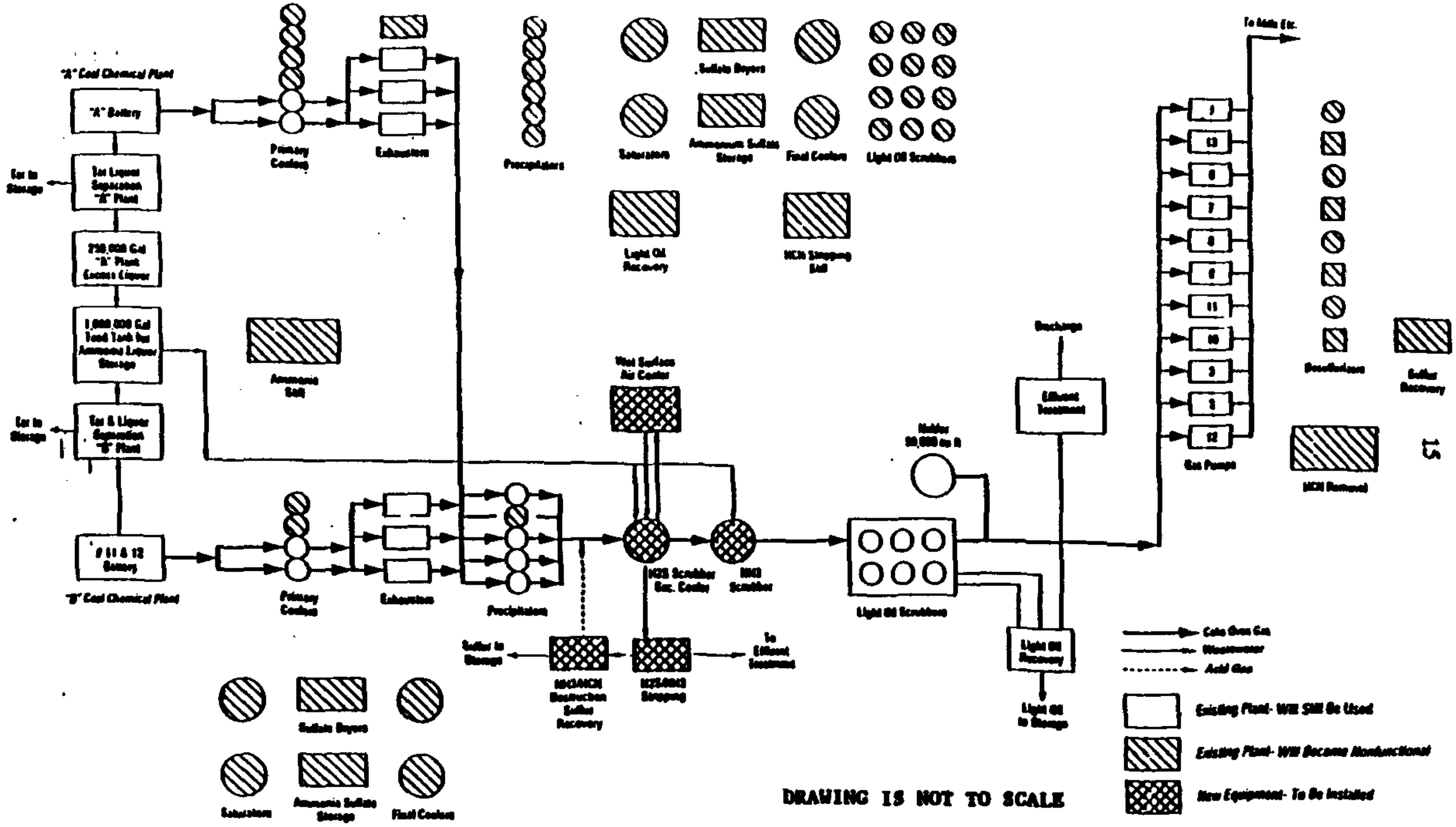

EQUIPMENT/FLOW DIAGRAM
FIGURE 2

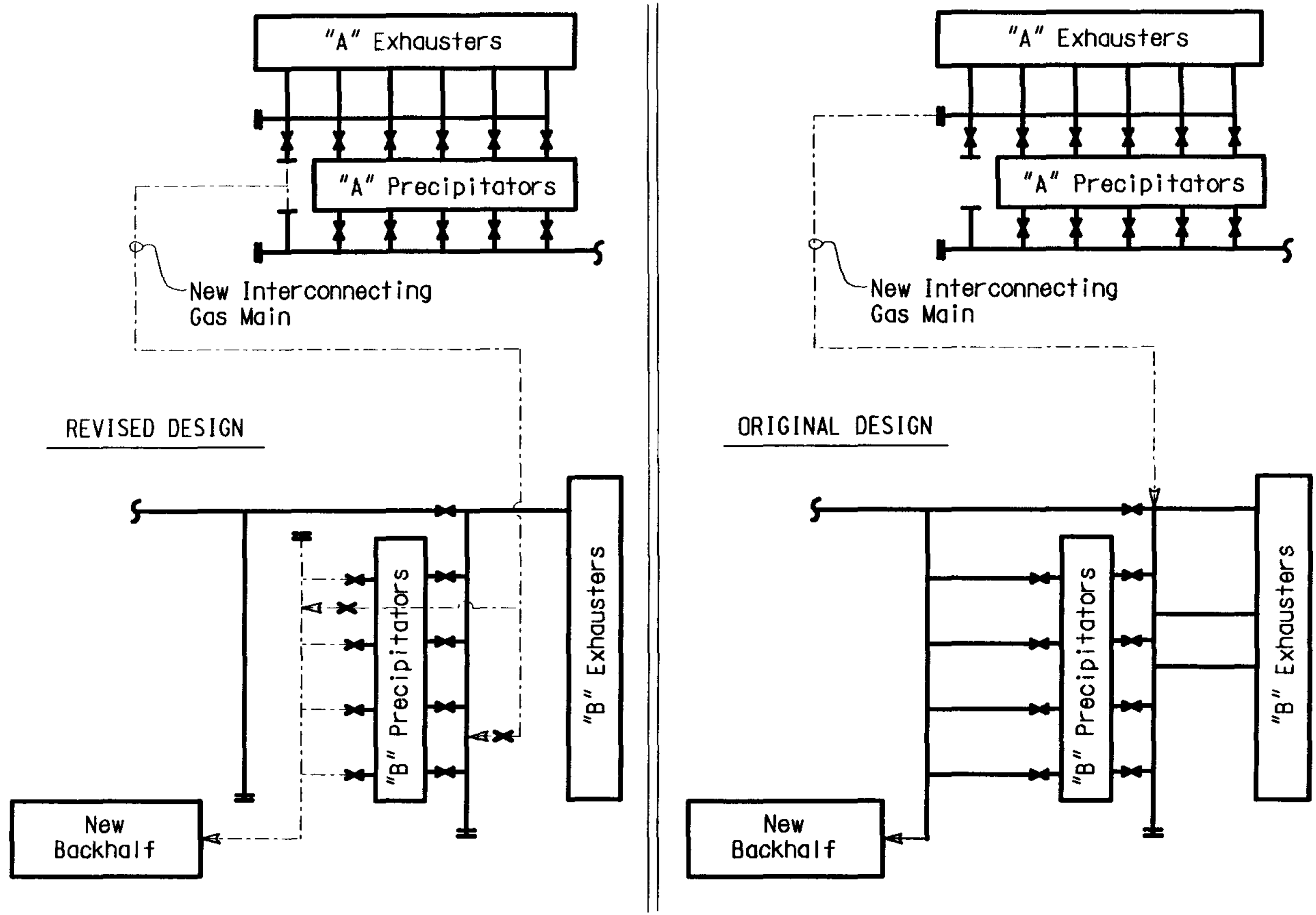

Figure 3 - Clean Coal Program - Sparrows Point Plant

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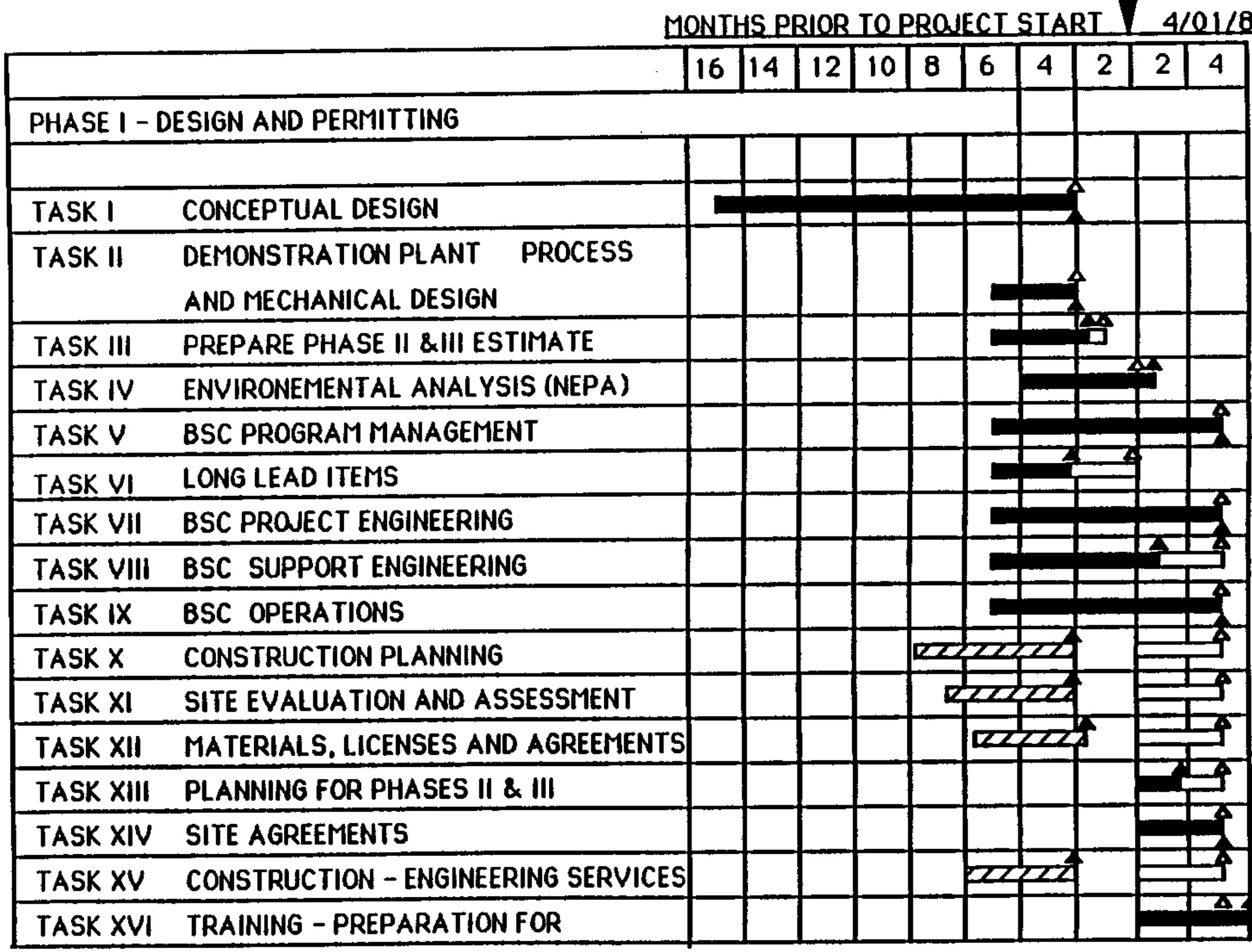
BETHLEHEM STEEL CORP / DOE

CLEAN COAL PROJECT

SPARROWS POINT, MD.



△ = ORIGINAL MILESTONE-COMPLETION

▲ = TASK COMPLETED (MAJOR OR INTERMEDIATE TASK)

* = REVISED TASK COMPLETION DATE(1ST,2ND,NTH REVISION)

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Table 1
Milestone Log for Phase I Tasks

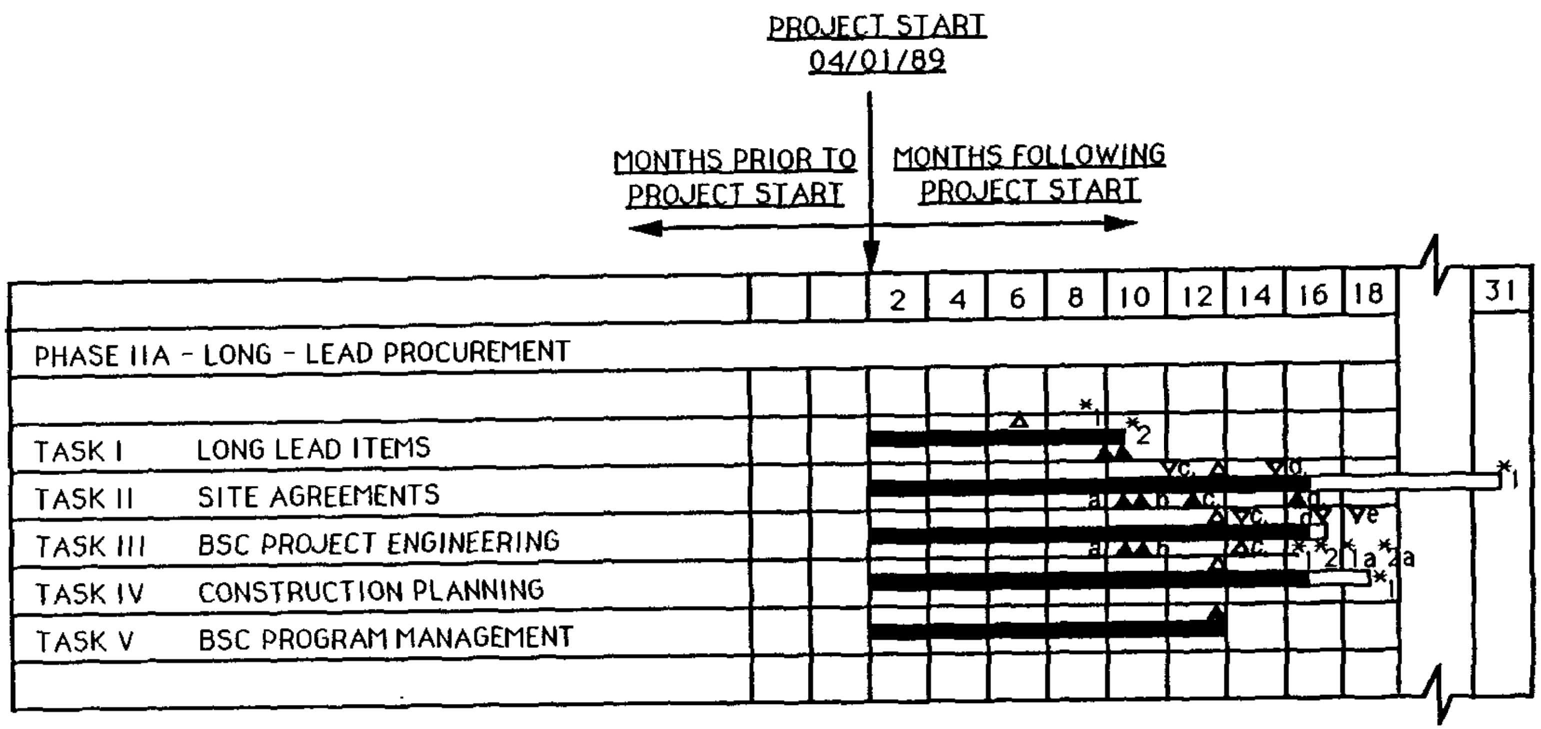
Task No.	Description	Planned Completion Date	Actual Completion Date	Comments
1	Conceptual Design	1/20/89	1/20/89	Final DSO Report
2	Process & Mechanical Design	1/20/89	1/20/89	Final DSO Report
3	Prepare Phase II & III Est.	3/01/89	2/17/89	FAR Submission
4	NEPA	4/01/89	4/30/89	ERM Report
5	BSC Program Management	6/30/89	6/30/89	-
6	Long Lead Items	4/01/89	1/23/89	1st DSO Schedule
7	BSC Project Engineering	6/30/89	6/30/89	-
8	BSC Support Engineering	6/30/89	4/30/89	Environmental Support
9	BSC Operations	6/30/89	6/30/89	-
10	Construction Planning	6/30/89	1/20/89	Final DSO Report
11	Site Evaluation	6/30/89	1/20/89	Final DSO Report
12	Materials, Licenses	6/30/89	1/20/89	Final DSO Report
13	Planning for II & III	6/30/89	5/31/89	DSO Contract Date
14	Site Agreements	6/30/89	6/30/89	Submit Permit Request
15	Construction - Eng. Serv.	6/30/89	1/20/89	DSO Final Report
16	Training	6/30/89	7/30/89	First Submission by DSO

FIGURE 5 - BETHLEHEM STEEL CORP / DOE

CLEAN COAL PROJECT

SPARROWS POINT, MD.

PHASE IIA SCHEDULE



▲ (outline) = ORIGINAL MILESTONE / COMPLETION DATE

▲ = TASK COMPLETED (MAJOR OR INTERMEDIATE TASKS)

$*_{1,2...N}$ = REVISED TASK COMPLETION DATE (1ST,2ND,NTH REVISION)

▼ = INTERMEDIATE EVENTS - SEE MILESTONE LOG

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10/16/89
REV. 06/30/90

MILESTONE LOG FOR PHASE IIA TASKS

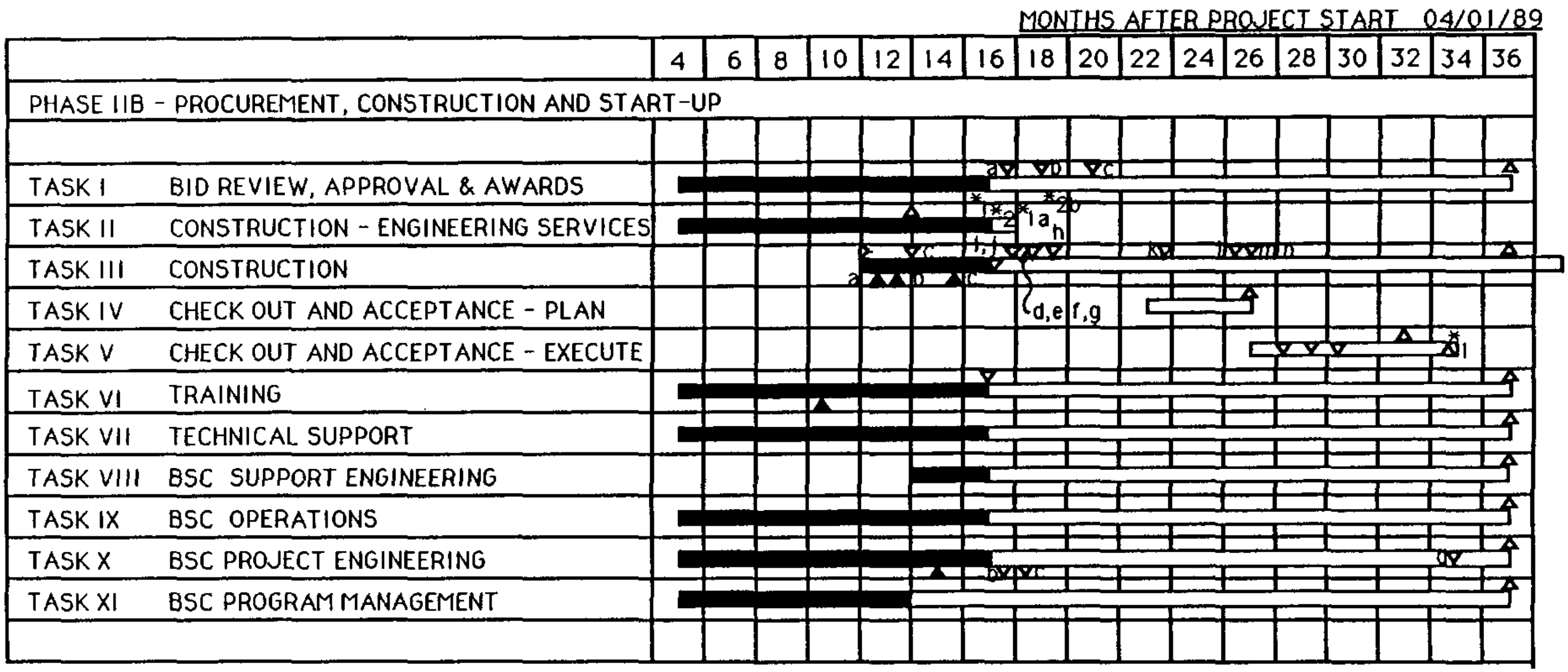
TASK NO.	DESCRIPTION	ORIGINAL COMPLETION DATE	INTERMEDIATE EVENTS	REVISED COMPLETION DATE	ACTUAL COMPLETION DATE	COMMENTS
1.	Long Lead Items	08/31/89				
	*1			11/30/89	11/30/89	All 6 month delivery orders except electrical substation, items placed.
	*2			12/15/89	12/08/89	Electrical substation order placed.
2.	Site Agreements	03/31/90		10/10/91		End date changed to reflect anticipated date of system acceptance.
	*1		a. 12/15/89		12/13/89	Date of Inquiry - piling contract
			b. 01/12/90		01/19/90	Date of Inquiry - foundation contract
			c. 02/28/90	04/06/90	04/04/90	Date of Inquiry - general construction contract
			d. 05/04/90		06/01/90	Date of Inquiry - electrical/control contract
3.	BSC Project Engineering	03/31/90				
	*1			06/15/90		End date changed to reflect placing of
	*1a			07/30/90		general construction contract.
	*2			07/16/90		End date changed to reflect placing of
	*2a			08/15/90		construction contract including electrics.
			a. 12/15/89		12/08/89	Complete long lead item review.
			b. 01/15/90		01/19/90	Place Contract - piling contractor
			c. 03/16/90	04/20/90	05/02/90	Place Contract - foundation contractor
			d. 06/01/90	07/30/90		Place Contract - general construction
			e. 07/16/90	08/15/90		Place Contract - electrical/control
4.	Construction Planning	03/31/90				
	*1			08/31/90		End date changed to reflect all major equipment on site.
			06/10/90	07/30/90		General construction contractor on site
5.	Program Management	03/31/90				Will continue to meet reporting deadlines.

FIGURE 6 - BETHLEHEM STEEL CORP / DOE

CLEAN COAL PROJECT

SPARROWS POINT, MD.

PHASE IIB SCHEDULE



△ = ORIGINAL MILESTONE / COMPLETION DATE

▲ = TASK COMPLETED

$*_{1,2...N}$ = REVISED TASK COMPLETION DATE(1ST,2ND,NTH REVISION)

▽ = INTERMEDIATE EVENT - SEE MILESTONE LOG

▷ = REVISED MILESTONE DATE - BEGIN TASK

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10/16/89
REV. 06/30/90

MILESTONE LOG FOR PHASE IIB TASKS

TASK NO.	DESCRIPTION	ORIGINAL COMPLETION DATE	INTERMEDIATE EVENTS	REVISED COMPLETION DATE	ACTUAL COMPLETION DATE	COMMENTS
1.	Bid Review, Approval and Awards	02/28/92				
			a. 06/01/90	07/30/91		Place general construction contract
			b. 08/31/90			All major equipment on site.
			c. 10/31/90			Final invoicing for equipment (except for retention)
2.	Construction Engineering	03/31/90				
	*1			06/15/90		Place construction contract.
	*1a			07/30/90		
	*2			07/16/90		Place Electrical/Control contract.
	*2a			08/15/90		
3.	Construction	02/28/92				
			a. 02/01/90		02/12/90	Start pile driving.
			b. 03/30/90		03/19/90	Complete pile driving.
			c. 04/02/90	04/30/90	05/21/90	Begin foundation construction.
			d. 06/01/90	07/30/90		Place general construction contract.
			e. 06/10/90	08/01/90		General contractor on site.
			f. 07/02/90			Begin erection of vessels and structural steel.
			g. 07/16/90	08/15/90		Place electrical/control contract.
			h. 09/01/90	10/30/90		End foundation construction.
			i. 09/04/90	10/01/90		Begin piping installation.
			j. 09/04/90	10/01/90		Begin electrical installation.
			k. 01/21/91			End erection of vessels and structural steel.
			l. 04/05/91			End piping installation.
			m. 04/24/91			End electrical installation.
			n. 05/01/91	05/31/91		End general construction.
4.	Check out and Acceptance Plan	05/01/91				

 MILESTONE LOG FOR PHASE IIB TASKS

TASK NO.	DESCRIPTION	ORIGINAL COMPLETION DATE	INTERMEDIATE EVENTS	REVISED COMPLETION DATE	ACTUAL COMPLETION DATE	COMMENTS
5.	Check out and Acceptance - Execute	10/31/91				
	*1			12/31/91		Meet compliance.
			a. 05/01/91	05/31/91		Begin cold commission.
			b. 07/01/91	07/31/91		End cold commission.
			c. 07/02/91	07/31/91		Begin hot commission.
			d. 08/02/91	08/30/91		End hot commission.
			e. 08/02/91	08/30/91		Begin punch list.
			f. 12/10/91	12/31/91		End punch list.
6.	Training	02/28/92				
			11/30/89		11/30/89	Draft of training manuals.
			06/01/90			Complete training manuals.
7.	Technical Support	02/18/92				Ongoing as required.
8.	BSC Support Engineering	02/28/92				Ongoing as required.
9.	BSC Operations	02/28/92				
			xxx			Begin training.
			xxx			End training.
10.	BSC Project Engineering	02/28/92	a. 04/12/89		04/12/89	Begin monthly engineering team meetings.
			b. 05/31/90	07/16/90		End monthly engineering team meetings.
			c. 06/01/90	08/16/90		Begin monthly construction team meetings.
			d. 12/31/91			End monthly construction team meetings.
11.	BSC Program Management	02/28/92				Will continue to meet reporting deadlines.

FIGURE 7 TOTAL PROJECT COST VS. DOE COST SHARE THROUGH 2ND Q 1990

COKE OVEN GAS CLEANING SYST.FOR RETROFIT APPLIC.

A&B COAL CHEM. PLANTS, SPARROWS POINT, MD.

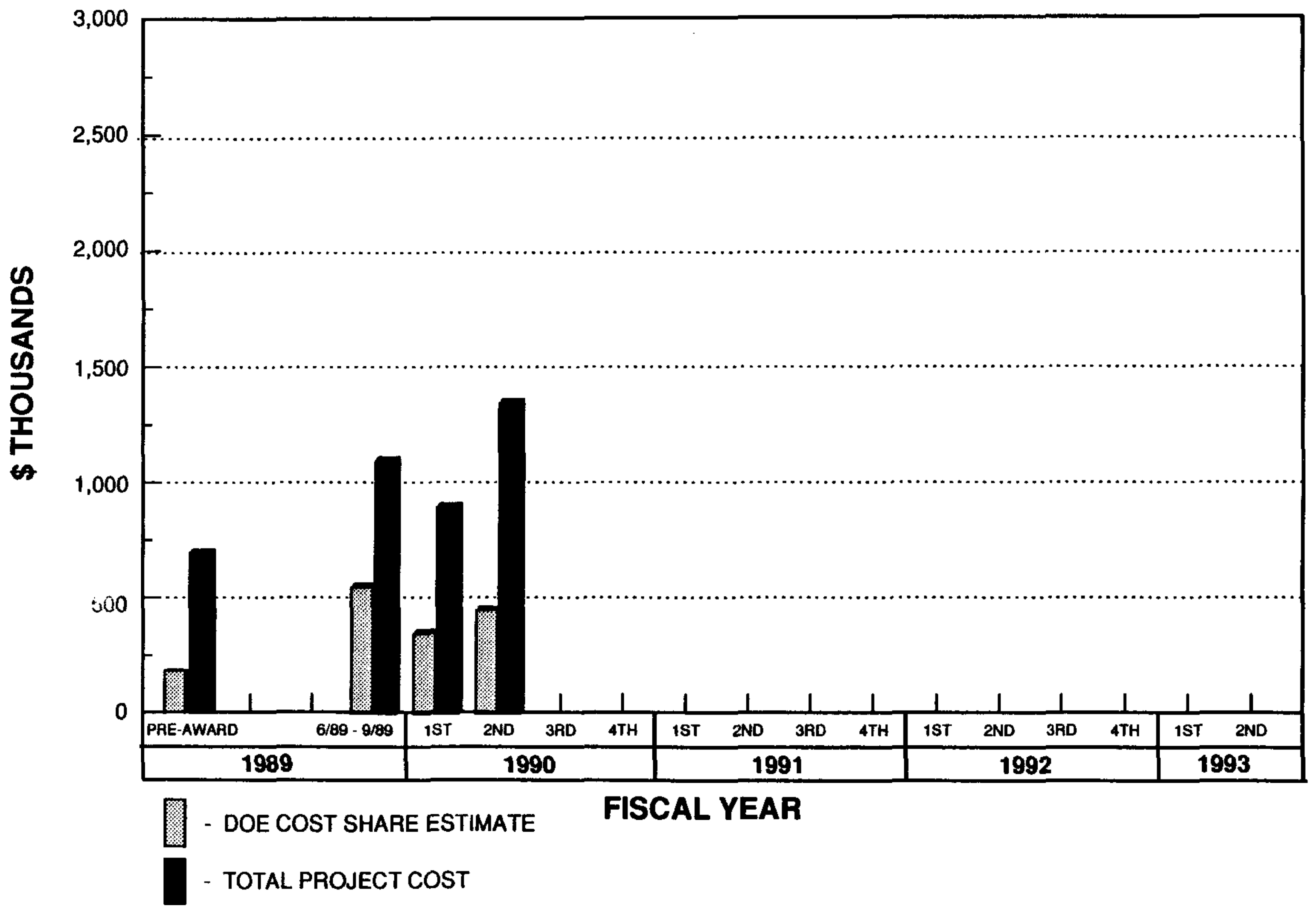

FIGURE 8 CUMULATIVE SPENDING SCHEDULE

COKE OVEN GAS CLEANING SYST.FOR RETROFIT APPLIC.

A&B COAL CHEM. PLANTS, SPARROWS POINT, MD.